HyspIRI and ECOSTRESS Applied Science and Research Activities

Christine Lee (Jet Propulsion Laboratory, California Institute of Technology)
Jeff Luvall (MSFC), Simon Hook (Jet Propulsion Laboratory, California Institute of Technology)

Sol Kim (NASA DEVELOP 2016-2017)
Woody Turner (NASA HQ)

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Thank you for support from mission teams, NASA Applied Sciences, DEVELOP program, and science team members from ECOSTRESS and beyond.

Future missions will need to propose a project specific applications program in accordance with this document and presented to ESD for approval at KDP-B.

Purpose of Directive

- Scope / develop applied research and applications as part of mission concept
- Demonstrate benefit of project to society
- Identify specific applications (and communities of potential)
- Increase utility of data products
- Foster community of practice who partners with project throughout mission life cycle

NASA HEADQUARTERS
SCIENCE MISSION DIRECTORATE (SMD)

EARTH SCIENCE DIVISION

DIRECTIVE ON PROJECT APPLICATIONS PROGRAM

Approved by:

Michael Freilich
Director, Earth Science Division
Science Mission Directorate, NASA Headquarters

29 June 2016
Date

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Requirement for **future missions**

Opportunity to lay groundwork with ECOSTRESS and support HyspIRI's response to this directive

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Some important takeaways from the signed directive

- Provides guidance for a project applications plan
- Puts onus on missions to incorporate applications at mission concept and throughout mission life cycle

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Examples of Activities and Deliverables

- Community engagement/assessment
- Applied project studies
- Project applications plan
- Applications Traceability Matrix
- Early Adopter workshops and activities
- Workshops, Tutorials, Short Courses
- Use case studies and reports
- Posters / Talks
- Simulated data products
- Impact assessments

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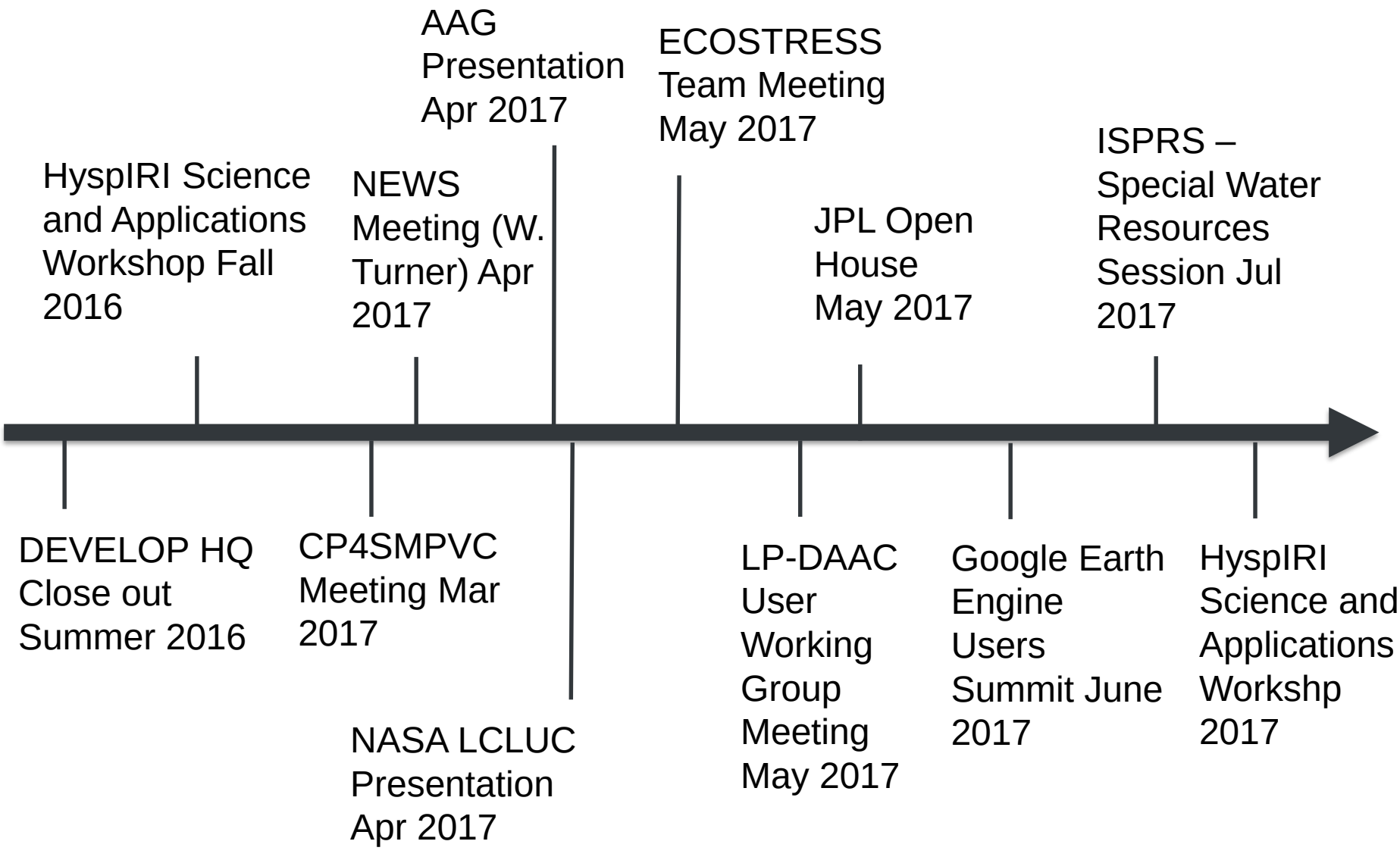
Community Engagement



Applied Project Studies

Timeframe	Title / Goal	Partner	Status
Summer 2016	Applying Diurnal ECOSTRESS Temperature and ET to Agriculture	EARTH University	Final Report and Presentation Available
Fall 2016	Analyzing Advantages of ECOSTRESS data as a Tool for Drought Detection and Water management	EARTH University	Final Report, Presentation Available, Publication in progress (Presentation coming up)
Fall 2016 – Summer 2017	Evaluating Biophysical Parameters of Drought over Guanacaste Region of Costa Rica	EARTH University	Interim Reports and Presentations Available, Publication in progress (Presentation coming up)
Fall 2016 – Summer 2017	Evaluating performance of ECOSTRESS simulated data in ET model intercomparison over San Francisco Bay Delta	CA DWR	Interim Reports (Presentation coming up)
Winter 2017	Potential Applications of ECOSTRESS Products in Plant Phenotyping and Predicting Patterns in Global Species Richness	USDA	Final Report, Presentation Available, Publication in progress (Presentation coming up)

Public Health Applications

- **Gates Foundation -** Provide proof of concept data on the ability to create unique immature aquatic *Anopheles* species habitat spectral signatures and part of a the Environmental Surveillance and Monitoring System Product- May 1, 2017 6 month funding initially Cambodia (Univ of South Flordia, Bob Novak, PI)

- **Climate City –** *French Initiative*. RS to characterize the urban climate, UHI, air quality, hydrology, social-economic, etc. Luvall member of Scientific Steering Committee. Preparing International Space Act for NASA participation

- **USAID IDIQ** - Prevention of Mosquito-Borne Diseases Through Vector Control SOL-OAA-16-000179. Support entomological and epidemiological monitoring and provide technical support for strategic decision making and deployment of vector control interventions for malaria control. 22 countries in Africa. mid May 2017 selection.

HysplRI Application TM

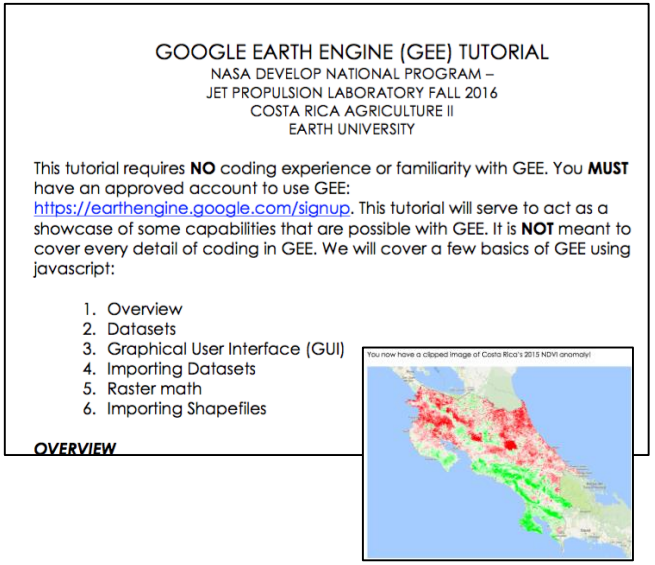
Application Question	Application Concept	Application Measurement Goals	Applied Sciences Category	Potential Host Agency	Mission Data Product	Projected Mission Performance	ARL	Ancillary Measuremen
How do we schedule water releases & determine availability for irrigation use?	The major pathway of water transport in the hydrologic cycle is evapotranspiration(ET). ET is difficult to measure directly for large areas and determination of ET relies on a combination of models and surface parameterizations. Accurate determination of surface temperatures is critical in model parameterizations.	Spatial variability of landscape elements necessaite fine spacial resolution measurements ~ 60m. Repeat measurements of approximately 5 days are required to constrain ET models.	Water Management Agriculture	Western Governors Association 1600 Broadway Suite 1700 Denver, CO 80202 303 623-9378 Sebal North America 1772 Picasso Avenue Suite E Davis, California Phone: (530) 757 9200	Surface temperature	Measure surface temperature within 0.5 K , 60 m resolution and 5 day repeat cycle.	9	SEBAL, other ET models, agricultural cro indentification/management info, strea soils
What is the species diversity and habitat of key water resources. Focused studies at specific locations e.g. Comprehensive Everglades Restoration Plan (CERP)	Characterize ET patterns and functional classification of ecosystems (carbon binding& storage, species diversity), and land-use/type	30-60m spatial resolution, 3-5 day therm measurements (0.5K)		Barry Rosen (Vice Chair) Biologist U.S. Geological Survey Office of	Surface temperature	Measure surface temperature within 0.5 K , 60 m resolution		
What is the extent and the condition of coral reefs ecosystems ?	Characterize the physical, chemical, and biological status of coastal and estuarine environments and ecosystems worldwide.	Hyperspectral measurements of coastal provide spacial & spectral information fo management.						
What are the abiotic environmental factors are important in determining the distribution of disease-causing vectors and their life-cycles? Monitoring targeted tropical diseases for elimination-rpogress & indicators. Generate disease risk maps reliable to the date when the epidemiological survey occurs and to only the areas covered with the survey	HysplRI observations can be merged through a Land Data Assimilation System (LDAS) be used to drive spatially-explicit ecological models of NTD vectors distribution & life cycles. Assimilations will be driven by observational data LDAS and satellite-derived meteorological forcing data, parameter datasets, and assimilation observations.	Spatial variability of landscape elements fine spacial resolution measurements ~ 6 Repeat measurements of approximately required for enviromental measurement for hyperspectral vegetation mapping/ph status						
What is the composition of dust sources globaly and what role does surface mineralogy and biotic crusts play in accessing the impact of dust in human health.	Global transport of dust is well documented. The health impacts from microrganisms and mineralogy are just now beginning to be understood. The source of the dust is significant in determining its possible health affects. HysplRI hyperspectral measurements would provide global measurements of surface mineralogy and biotic crusts. HysplRI surface thermal measurements would also help identify the variability of dust sources due to surface moisture conditions and map mineralogy.	Spatial variability of landscape elements fine spacial resolution measurements ~ 6 Repeat measurements of approximately required for enviromental measurement moisture). 19 days for hyperspectral min mapping.						
What is the land-use and productivity of the intercoastal waters & barrier islands, e.g. Monitoring Gulf Mexico - spawning cycles, migration, land-use, productivity.	Characterize the physical, chemical, and biological status of coastal and estuarine environments and ecosystems.	Spatial variability of landscape elements fine spacial resolution measurements ~ 6 Repeat measurements of approximately required for enviromental measurement for hyperspectral vegetation mapping/ph status.						
How does surface water temperature affect manatee migration	Characterize patterns and trends in fine spacial scale river, estuarine, and near coastal water temperatures.	30-60m spatial resolution, 3-5 day therm measurements (0.5K). At least 1 nightime measurement within the 3-5 dya window						

ECOSTRESS Application Questions & Concepts

Application Question	Application Concept	Application Measurement Requirements	Applied Sciences Category	Potential Host Agency	Data Product	Projected Mission Performance
How can agricultural vulnerability be reduced through the advanced monitoring of crop heat and water stress?	ECOSTRESS will be able to measure evapotranspiration (ET) through a diurnal cycle due to the unique overpass cadence of the ISS. This will allow farmers to know where, when, and how much to irrigate crops.	**Spatial Resolution:** Farm scale <1 km **Latency:** <1 week	*Water Resources*	EARTH University, Water Resource Agencies, USDA, FAO	**L3 Product: Evapotranspiration (ET)**	Spatial resolution of 38m by 69m and a temporal resolution of 4 days
How can farmers and water resource agencies reduce vulnerability through improved detection of impending drought?	Evaporative Stress Index (ESI) measurements from ECOSTRESS will be able to provide early warnings of drought allowing a variety of agencies to mitigate harms.	**Spatial Resolution:** Farm scale <1 km **Latency:** <1 week	*Water Resources, Disasters, Human Health and Air Quality*	Water Resource Agencies, USDA (Martha Anderson), FAO	**L4 Product: Evaporative Stress Index (ESI)**	Spatial resolution of 38m by 69m and a temporal resolution of 4 days
How can remotely sensed plant phenotyping improve the speed and scale of selecting superior (drought/heat tolerant) crop varieties?	Non-destructive, image-analysis based phenotyping via remote sensing is a developing field of research. ECOSTRESS will provide plant breeders with key plant traits such as Water Use Efficiency (WUE).	**Spatial Resolution:** Farm scale <1 km **Latency:** <1 week	*Water Resources, Capacity Building*	USDA, FAO	**L3 Product: Evapotranspiration** **L4 Products: Evaporative Stress Index (ESI) and Water Use Efficiency (WUE)**	Spatial resolution of 38m by 69m and a temporal resolution of 4 days
What contributes to the urban heat island effect and how can these effects be mitigated?	The urban heat island effect results in increased energy, costs, health risks, and ozone. Understanding the contributing factors can allow city planners/managers to mitigate this effect by addressing the factors that lead to it (i.e. increase roof albedo)	**Spatial Resolution:** Urban scale <1 km **Latency:** Seasonal	*Human Health and Air Quality*	City Planners/Managers	**L2 Product: Land Surface Temperature**	Spatial resolution of 38m by 69m and a temporal resolution of 4 days
How can ECOSTRESS build capacity in the US and beyond for improved access and applications of NASA Earth Observations?	Participants and project partners in the NASA DEVELOP program are utilizing simulated ECOSTRESS data products. Collaboration has increased participant and partner capacity to apply NASA's Earth Science.					

Tutorials, Workshops, Short Courses

Tutorial	Team	Participants
• Summer 2016: Tutorial to produce simulated ECOSTRESS Land Surface Temperature	• Led by Glynn Hulley	• UCDavis, USDA, NOAA, JPL
• Summer 2016: An overview of evapotranspiration and agricultural applications	• Led by DEVELOP team	• EARTH University, JPL
• Fall 2016: Using Google Earth Engine to process and produce NDVI/ET maps	• Led by Sol Kim and DEVELOP team	• EARTH University


GOOGLE EARTH ENGINE (GEE) TUTORIAL
NASA DEVELOP NATIONAL PROGRAM –
JET PROPULSION LABORATORY FALL 2016
COSTA RICA AGRICULTURE II
EARTH UNIVERSITY

This tutorial requires **NO** coding experience or familiarity with GEE. You **MUST** have an approved account to use GEE: https://earthengine.google.com/signup. This tutorial will serve to act as a showcase of some capabilities that are possible with GEE. It is **NOT** meant to cover every detail of coding in GEE. We will cover a few basics of GEE using javascript:

1. Overview
2. Datasets
3. Graphical User Interface (GUI)
4. Importing Datasets
5. Raster math
6. Importing Shapefiles

OVERVIEW

Credit: Sol Kim

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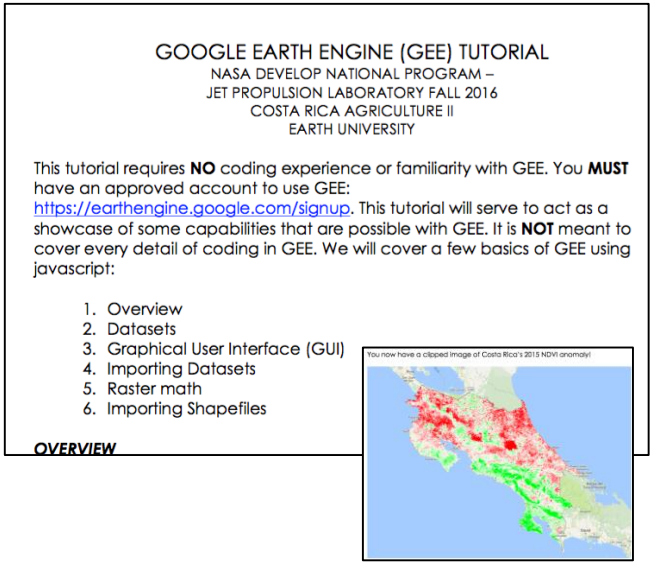
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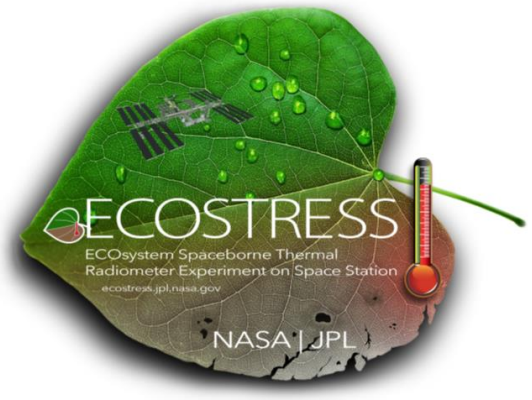
Increase partnerships around applied work with LP-DAAC and other areas in NASA ASP (Capacity Building, DEVELOP, ARSET).

White Papers (Pre-cursor to Use Cases)

Future Considerations and Plans for ECOSTRESS and HyspIRI

- ECOSTRESS progress towards building applications can help HyspIRI get a headstart on the PAP / NASA directive
- Continue to leverage various resources to demonstrate ECOSTRESS / HyspIRI applications utility
- Need to actively centralize use cases and user data requirements for applications
- If there are value-added applications products, we would like to hear about them and scope out the opportunity

christine.m.lee@jpl.nasa.gov
hyspiri.jpl.nasa.gov
ecostress.jpl.nasa.gov



Applied Sciences Program

NASA Earth Science